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(54) **INTERACTIVE LIGHTING CONTROL SYSTEM AND METHOD**

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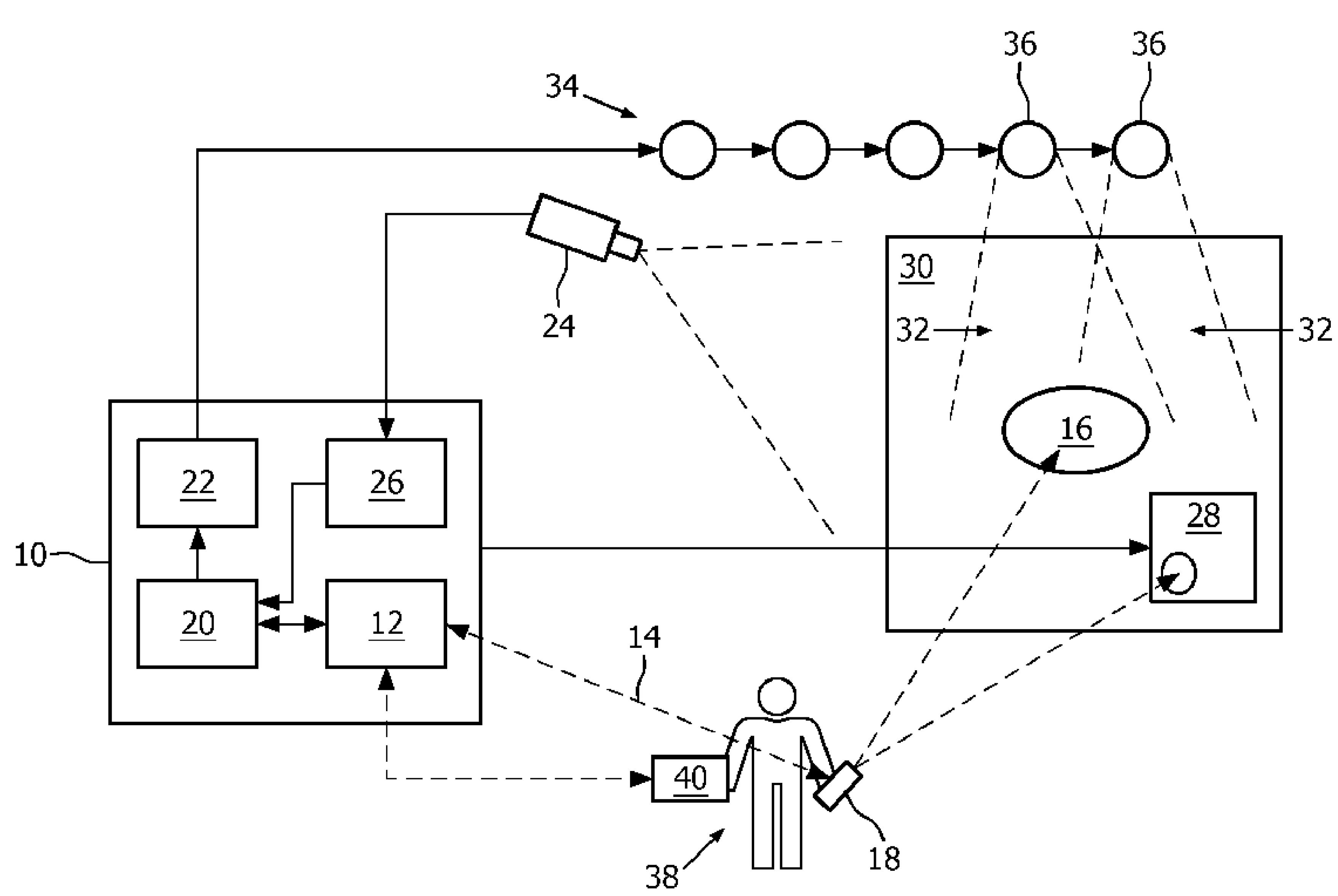
Primary Examiner — Darrin Dunn

(57) **ABSTRACT**

Interactive lighting control system (and method) for controlling and creating of light effects such as the tuning of light scenes based on location indication received from an input device. A basic idea of the claimed system is to provide an interactive lighting control by combining a location indication with a light effect driven approach in lighting control in order to improve the creating of light effects such as the tuning of light scenes especially with large and diverse lighting infrastructures. The claimed interactive lighting control system (**10**) comprises—an interface (**12**) for receiving data (**14**) indicating a real location (**16**) in a real environment from an input device (**18**), which is adapted to detect a location in the real environment by pointing to the location, and for receiving data related to a light effect (**32**) desired at the real location, and—a light effect controller (**20**) for mapping the real location to a virtual location of a virtual view of the real environment and determining light effects available at the virtual location.

13 Claims, 4 Drawing Sheets



(58) **Field of Classification Search**
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See application file for complete search history.

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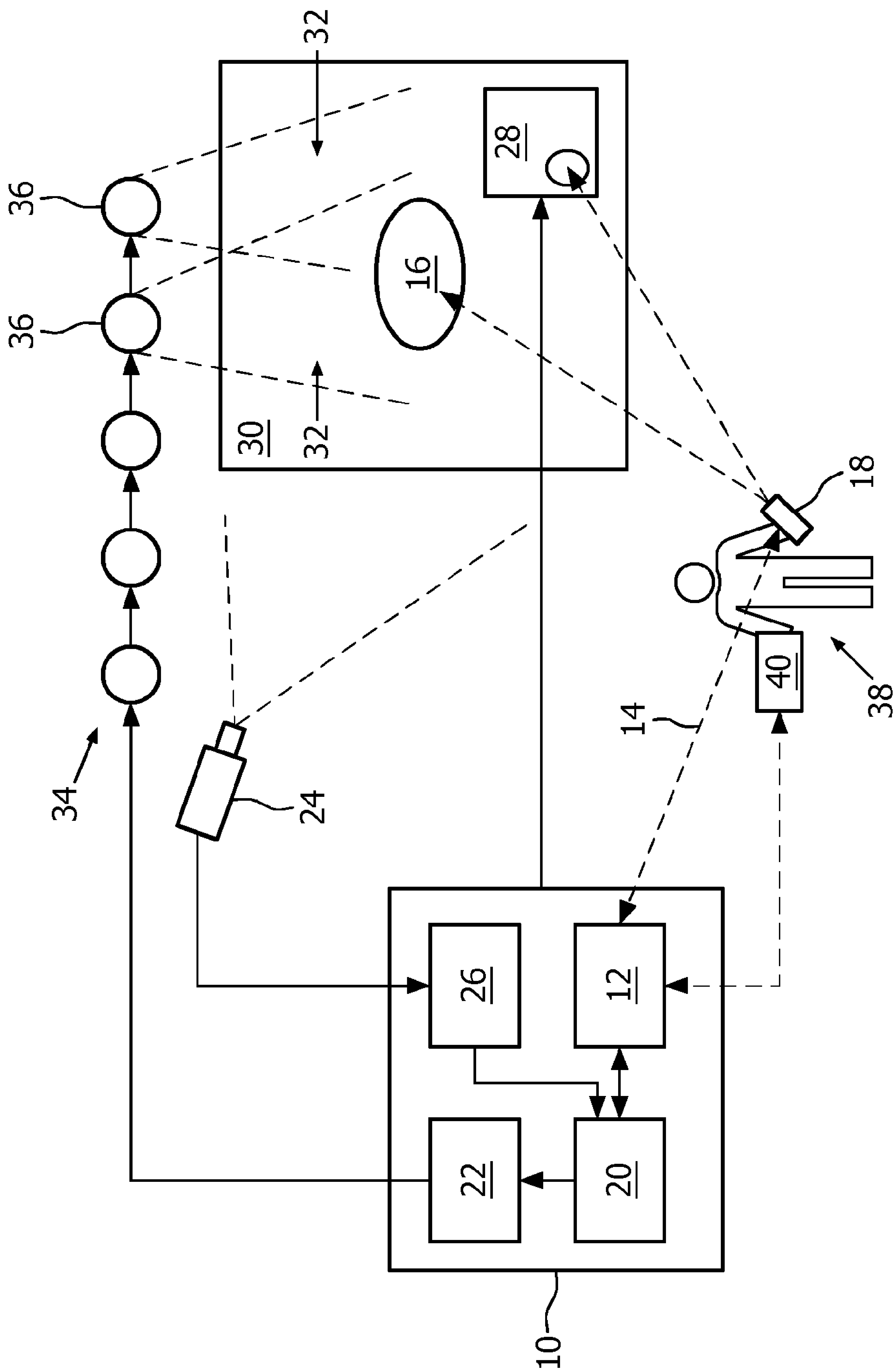

FIG. 1

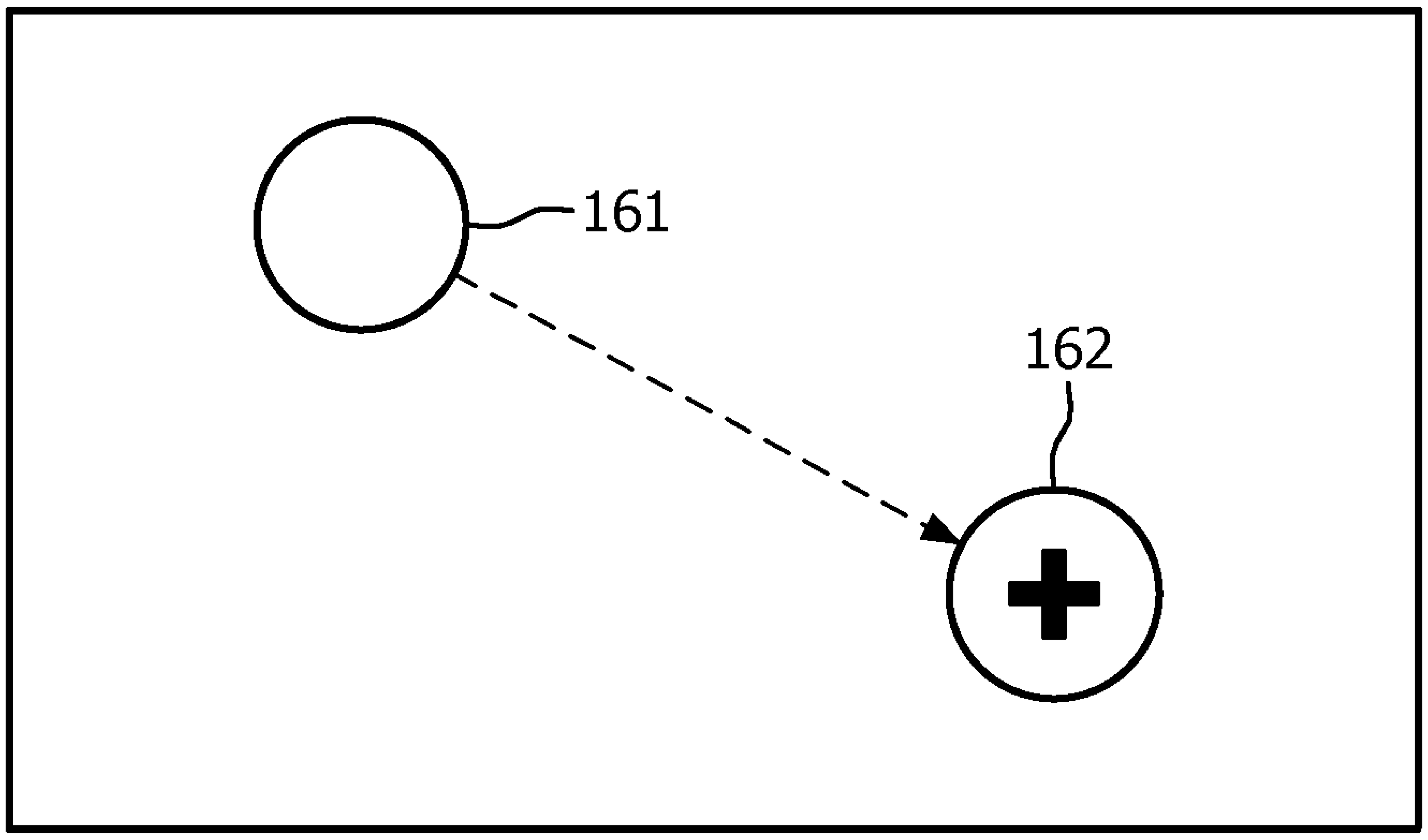

FIG. 2

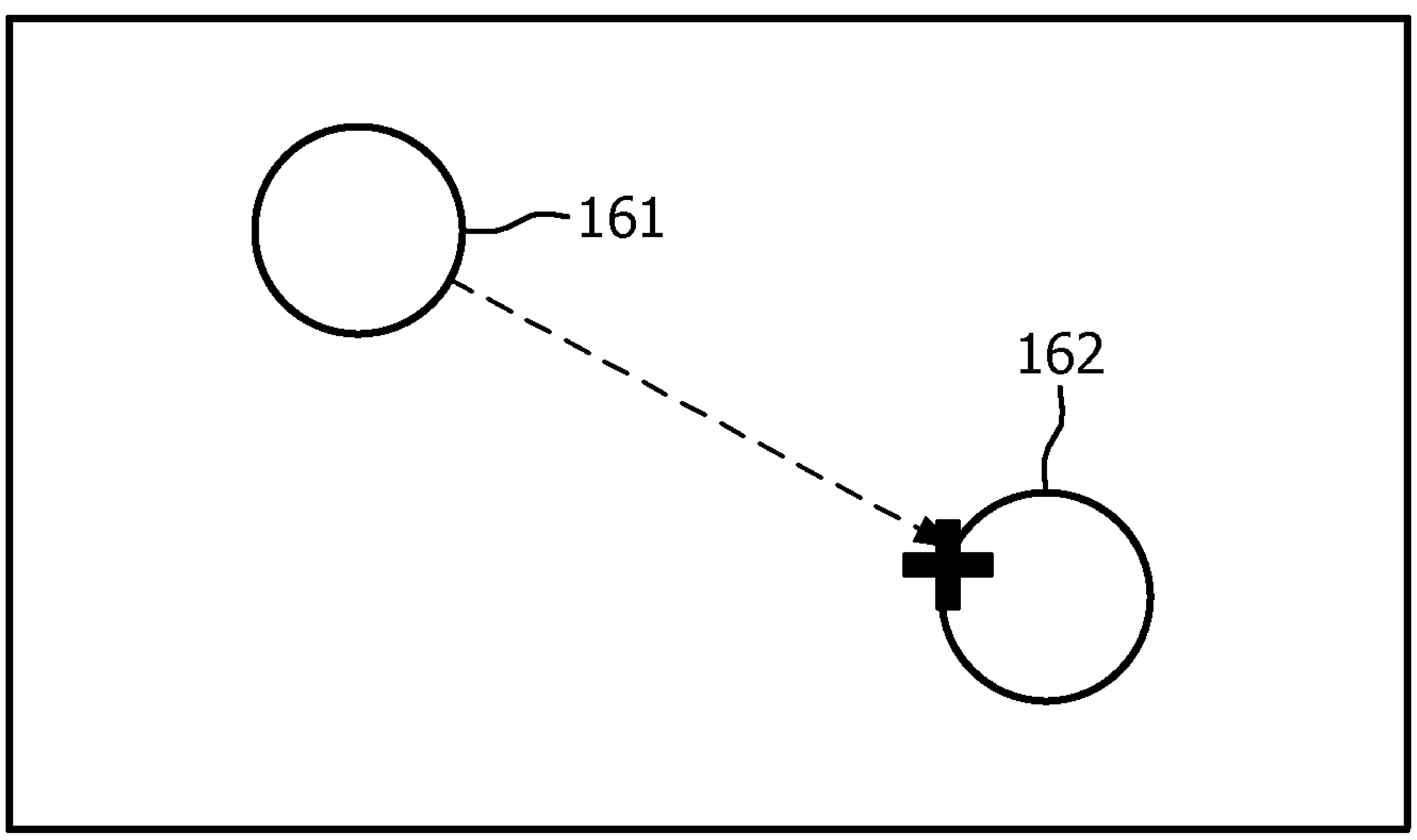

FIG. 3

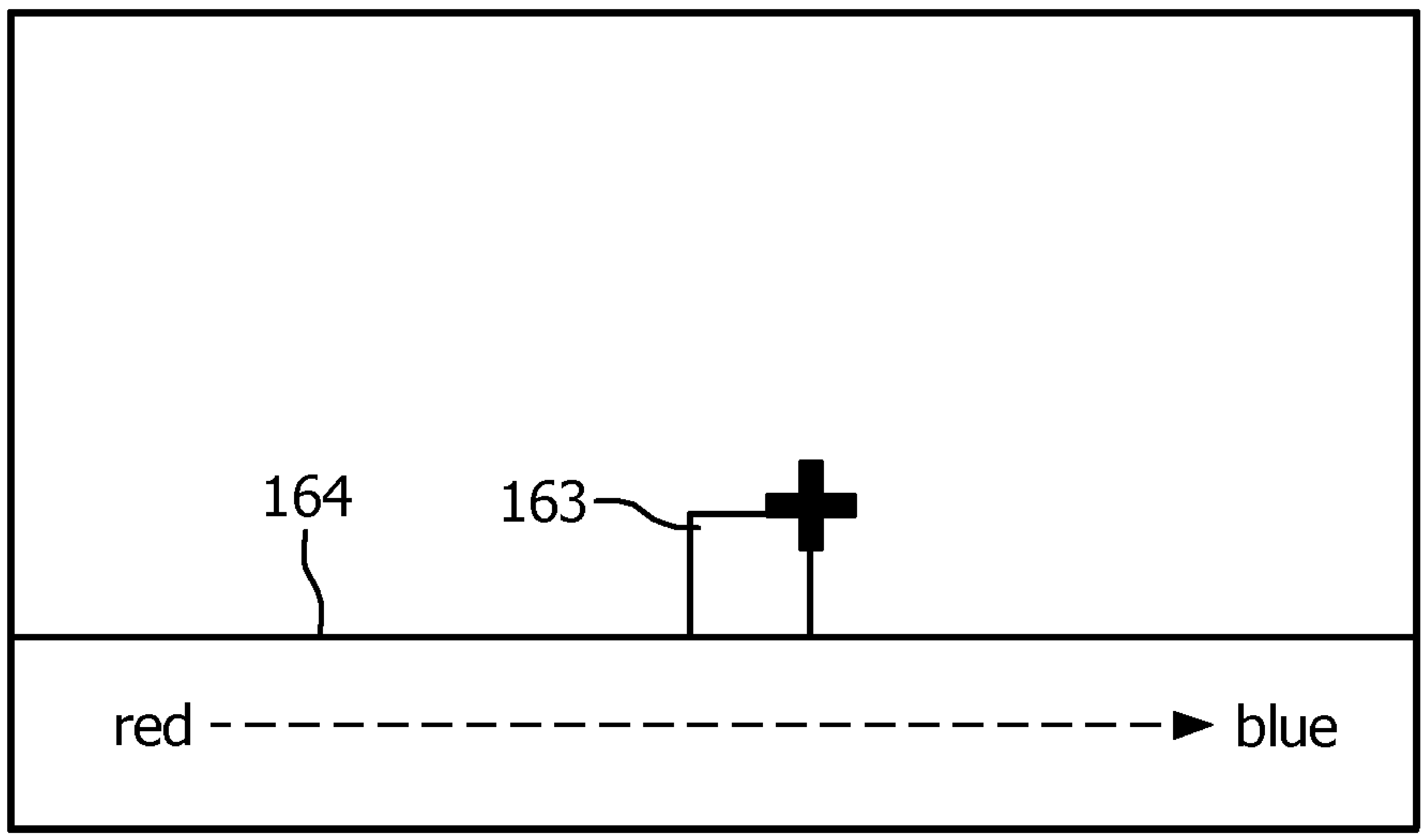

FIG. 4

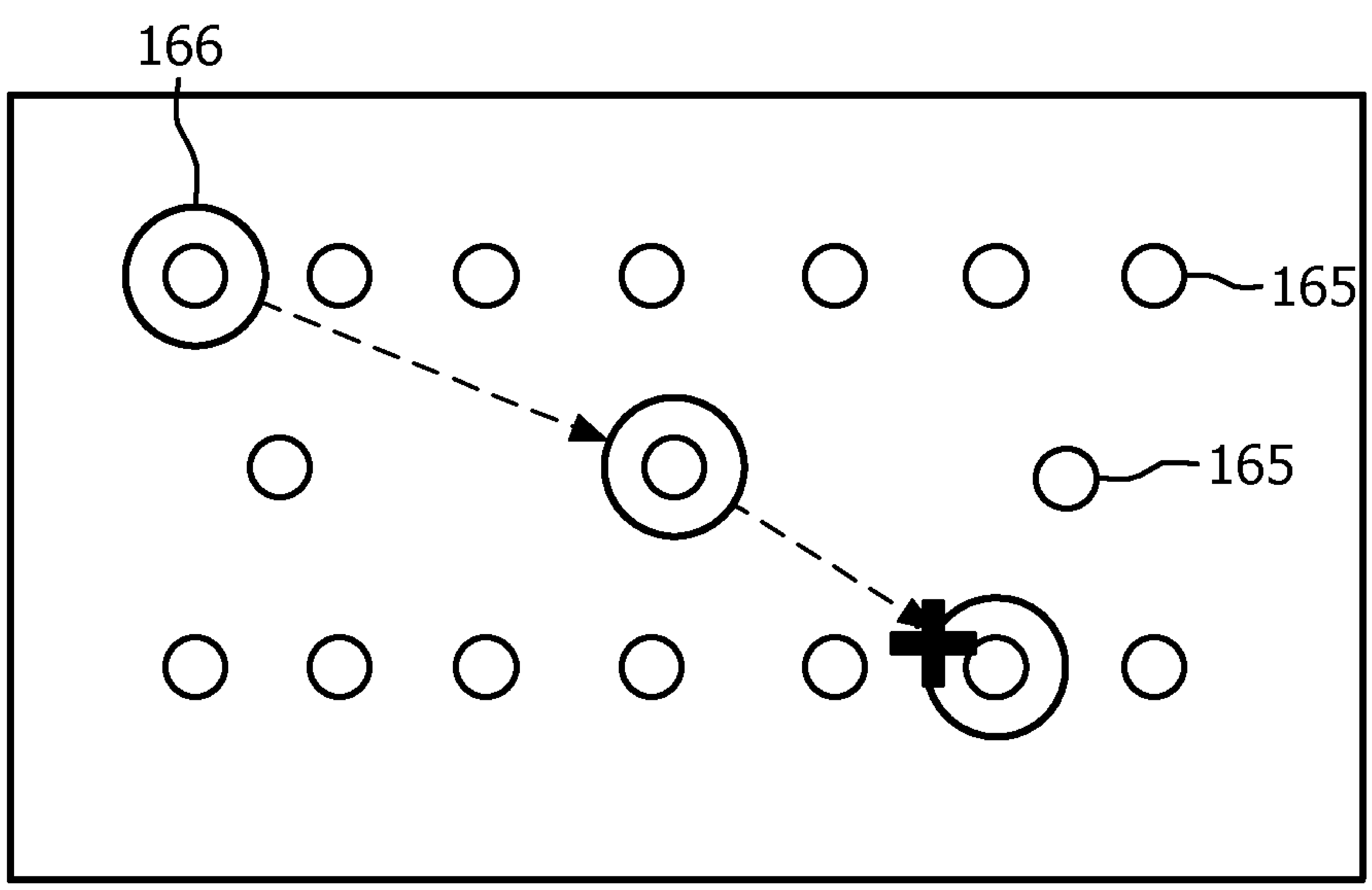

FIG. 5

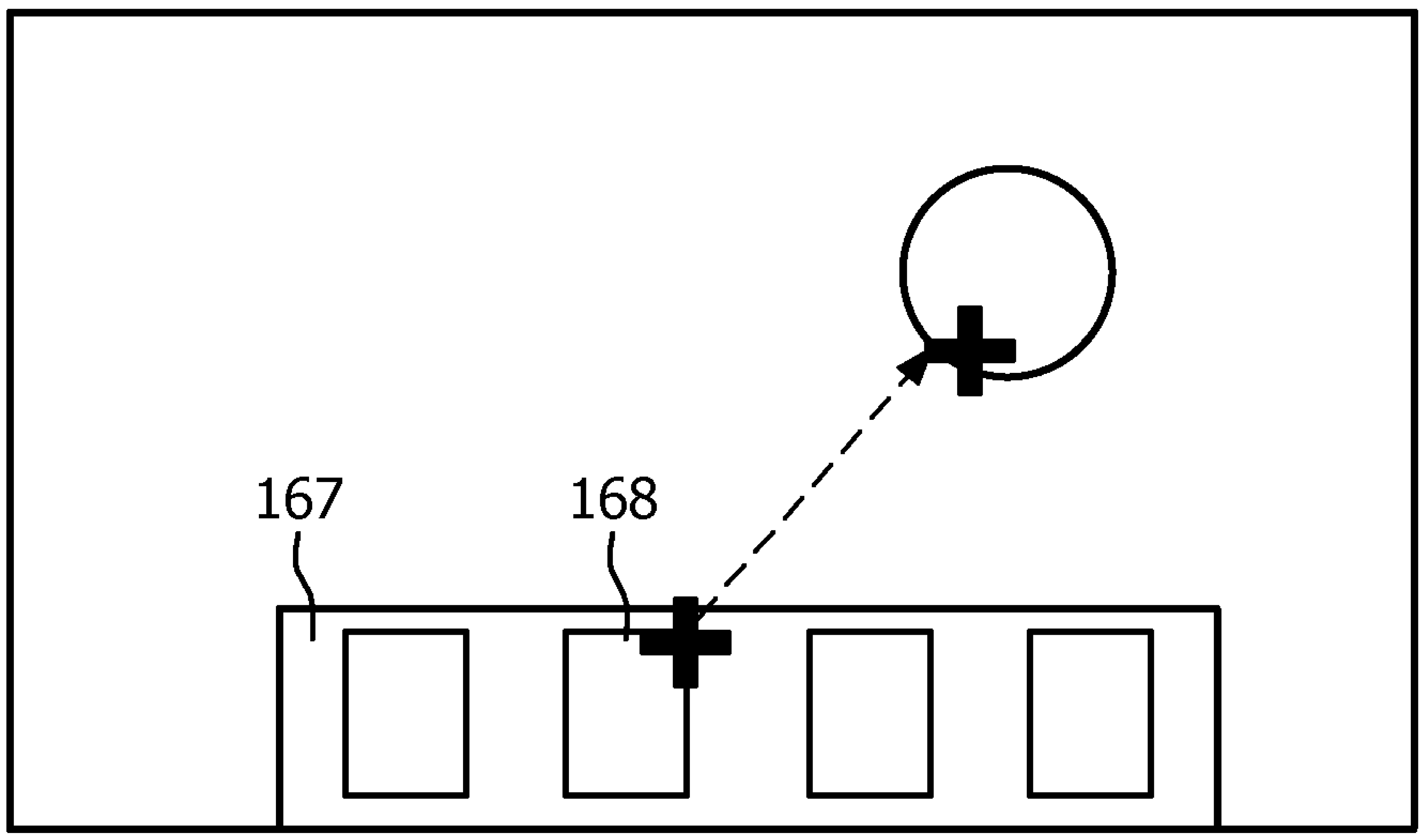

FIG. 6

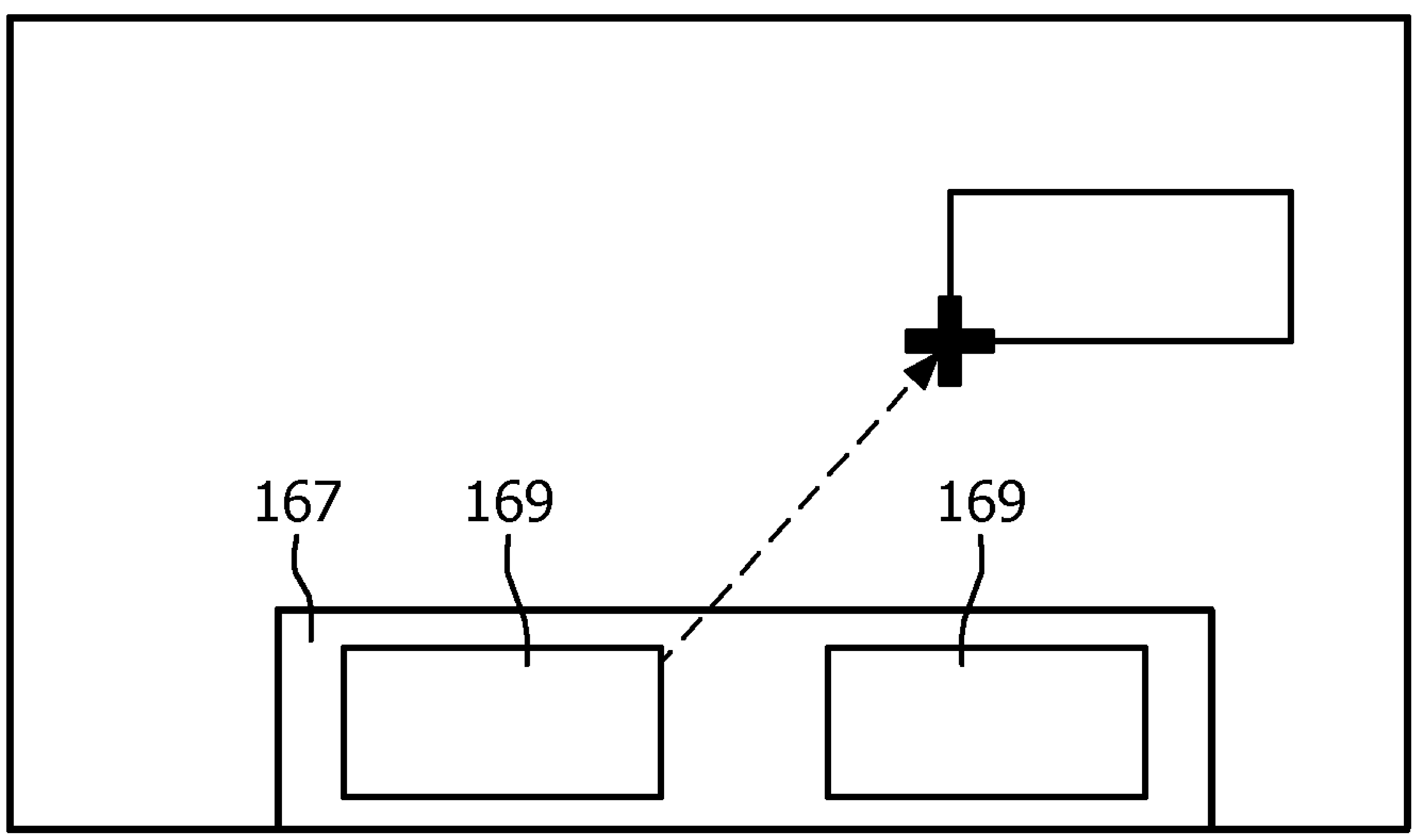

FIG. 7

INTERACTIVE LIGHTING CONTROL SYSTEM AND METHOD

TECHNICAL FIELD

The invention relates to interactive lighting control, particularly to the controlling and creating of light effects such as the tuning of light scenes based on location indication received from an input device, and more particularly to an interactive lighting control system and method for light effect control and creation with a location indication device.

BACKGROUND ART

Future home and current professional environments will contain a large number of light sources of different nature and type: incandescent, halogen, discharge or LED (Light Emitting Diode) based lamps for ambient, atmosphere, accent or task lighting. Every light source has different control possibilities like dimming level, cold/warm lighting, RGB or other methods that change the effect of the light source on the environment.

Almost all of the control paradigms in lighting are lamp driven: the user selects a lamp, and operates directly on the controls of the lamp by modifying the dimming value, or by operating on the RGB (Red Green Blue) channels of the lamp. While it can be very natural to adjust the lighting effect on the location directly and not be bothered by looking for the lamps that are responsible for the effect on the location.

When the number of light sources is greater than 20, it can be difficult to trace an effect on a location back to the light source. Moreover, the effect might be the result of a combination of different light effects from light sources of different natures (e.g. Ambient TL (Task Lighting) and wall washing LED lamps). In that case, the user has to play with the lighting controls of the different lamps, and has to evaluate the effect of changing them. In some cases, this effect is rather global (e.g. for ambient lighting), in some cases, this effect is very local (e.g. a spot light). So the user has to find out, which control is related to which effect, and has to find out the size of the effect in order to approach the desired light setting.

SUMMARY OF THE INVENTION

It is an object of the invention to improve the controlling of a lighting infrastructure.

The object is solved by the subject matter of the independent claims. Further embodiments are shown by the dependent claims.

A basic idea of the invention is to provide an interactive lighting control by combining a location indication device with a light effect driven approach on lighting control in order to improve the creating of light effects such as the tuning of light scenes especially with large and diverse lighting infrastructures. The effect driven approach in lighting control can be implemented by a computer model comprising a virtual representation of a real environment with a lighting infrastructure. The virtual view may be used to map a real location to a virtual location in the virtual environment. Lighting effects available at the real location can be detected and modelled in the virtual view. Both the virtual location and the available light effects may then be used to indicate to a user light effects for selection, and to calculate control settings for a lighting infrastructure. This automated and light effect driven approach may improve the

controlling of a particularly complex lighting infrastructure and offers a more natural interaction, since users only have to point to the location of the real environment, where they would like to change the light effect created by the lighting infrastructure.

An embodiment of the invention provides an interactive lighting control system comprising

- an interface for receiving data indicating a real location in a real environment from an input device, which is adapted to detect a location in the real environment by pointing to the location, and for receiving data related to a light effect desired at the real location,
- a light effect controller for mapping the real location to a virtual location of a virtual view of the real environment and determining light effects available at the virtual location.

The system may further comprise a light effect creator for calculating control settings for a lighting infrastructure for creating the desired light effect on the real location based on the light effects available at the virtual location. The light effect creator may be for example implemented as a software module, which transfers light effects selected in the virtual view into light effects in the real environment. For example, when a user selects a certain location in the real environment for changing a light effect, and changes the light effect by means of the virtual view, the light effect creator may automatically process the changed light effect in the virtual view by calculating suitable control settings for creating the light effect in the real environment. The light effect creator also can take any restrictions of the lighting infrastructure in the real environment into account when creating a light effect.

The location input device may comprise one or more of the following devices:

- a first input device, which is adapted to derive the location from the detected position of infrared LEDs;
- a second input device, which is adapted to derive the location from the detected position of coded beacons;
- a light torch, which is detected by a camera;
- a laser pointer, which is detected by a camera.

Typically, a suitable input device in the context of the invention is a pointing device, i.e. a device for detecting a location to which a user points with the device.

The system may further comprise a camera and a video processing unit being adapted for processing video data received from the camera and for detecting the location in the real environment, to which the input device points, and outputting the detected real location to the mapping unit for further processing.

The interface may be adapted for receiving the data related to a light effect desired at the real location from a light effects input device.

The light effect controller may be adapted for indicating light effects available at the real location based on the virtual location in the virtual view and for transmitting available light effects to the input device, a display device, and/or an audio device for indication to a user.

The display device may be controlled such that a static or dynamic content with light effects is displayed for selection with a light effects input device.

The data related to a light effect desired at the real location can comprise one or more of the following:

- data about the size of the real location at which the desired light effect should be created;
- data about a light effect at a first real location dragged with an input device to a second real location at which the light effect should be created, too;

data about a light effect at a first real location dragged with an input device to a second real location to which the light effect should be moved;

data about a grading or fading effect in a particular area or spot.

The light effect creator may be adapted to trace back to lamps, which influence the light in the real location, of the lighting infrastructure based on the virtual location and to calculate the control settings for the lamps, which were traced back.

A further embodiment of the invention relates to an input device for a system according to the invention and as described above, wherein the input device comprises

a pointing location detector for detecting a location in the real environment, to which the input device points, and

a transmitter for transmitting data indicating the detected location.

The input device can further comprise

light effects input means for inputting a light effect desired at the location, to which the input device points, wherein data related to a desired inputted light effect are transmitted by the transmitter.

A yet further embodiment of the invention relates to an interactive lighting control method comprising the acts of

receiving data indicating a real location in a real environment from an input device, which is adapted to detect a location in the real environment by pointing to the location, and receiving data related to a light effect desired at the real location, and

mapping the real location to a virtual location to a virtual view of the real environment and determining light effects available at the virtual location.

An embodiment of the invention provides a computer program enabling a processor to carry out the method according to the invention and as described above. The processor may be for example implemented in a lighting control system such as in a central controller of a lighting system.

According to a further embodiment of the invention, a record carrier storing a computer program according to the invention may be provided, for example a CD-ROM, a DVD, a memory card, a diskette, internet memory device or a similar data carrier suitable to store the computer program for optical or electronic access.

A further embodiment of the invention provides a computer programmed to perform a method according to the invention such as a PC (Personal Computer). The computer may be for example implement a central controller of a lighting infrastructure.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

The invention will be described in more detail hereinafter with reference to exemplary embodiments. However, the invention is not limited to these exemplary embodiments.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** shows an embodiment of an interactive lighting control system according to the invention;

FIG. **2** shows a first use case of the interactive lighting control system according to the invention, wherein a light effect is dragged from one location to another location with an input device according to the invention;

FIG. **3** shows a second use case of the interactive lighting control system according to the invention, wherein a spot from a redirect able lamp is dragged from one location to another location with an input device according to the invention;

FIG. **4** shows a third use case of the interactive lighting control system according to the invention, wherein functions are provided in a virtual view to enhance interactions according to the invention;

FIG. **5** shows a fourth use case of the interactive lighting control system according to the invention, wherein location attractors are provided;

FIG. **6** shows a first embodiment of a fifth use case of the interactive lighting control system according to the invention, wherein the display device shows a static color palette; and

FIG. **7** shows a second embodiment of a fifth use case of the interactive lighting control system according to the invention, wherein the display device shows a dynamic color palette

DESCRIPTION OF EMBODIMENTS

In the following, functionally similar or identical elements may have the same reference numerals. The terms "lamp", "light" and "luminary" describe the same.

FIG. **1** shows an interactive lighting control system **10** comprising an interface **12**, for example a wireless transceiver being adapted for receiving wirelessly data from an input device **18**, a light effect controller **20**, a light effect creator **22**, and a video processing unit **26** for processing video data captured with a camera **24** connected to the interactive lighting system **10**. The interactive lighting control system **10** is provided for controlling a lighting infrastructure **34** comprising several lamps **36** installed in a real environment such as a room with a wall **30**. The system **10** may be implemented by a computer executing software implementing the modules **20**, **22** and **26** of the system **10**. The interface **12** may then be for example a Bluetooth™ or a WiFi transceiver of the computer. The system **10** may further be connected with a display device **28** such as a computer monitor or TV set.

Interactive control of the lighting created with the lighting infrastructure **34** may be performed by usage of the input device **18**, which may be hold by a user **38**. The user **38**, who desires to create a certain lighting effect at a real location **16** on the wall **30**, simply points with the input device **18** to the location **16**. In order to detect the location **16**, to which the user **38** points, the input device **18** is adapted to detect the location **16**.

The input device **18** may be for example the uWand™ intuitive pointer and 3D control device from the Applicant. The uWand™ control device comprises an IR (Infrared) receiver, which detects signals from coded IR beacons, which may be located at the wall **30** besides a TV set. From the received signals and the positions of the beacons, the uWand™ control device may derive its pointing position and transmit the derived pointing position via a wireless 2.4 GHz communication link to the interface **12**. The uWand™ control device makes 2D and 3D position detection possible. For example, also turning of the input device may be detected.

Also, the WiiMote™ input device from Nintendo Co., Ltd., may be used for the purposes of the present invention. The WiiMote™ input device allows a 2D pointing position detection by capturing IR radiation from IR LEDs with a built-in camera and deriving the pointing position from the detected position of IR LEDs. Transmission of data related to the detected pointing position occurs via a Bluetooth™ communication link, for example with the interface **12**.

Furthermore, a laser pointer or light torch may be applied as input device, when combined with a camera for detection the pointing position in the real environment, for example on the wall **30**. Data related to the detected pointing position are generated by a video processing of the pictures captured with the camera. The camera may be integrated in the input device similar to the WiiMote™ input device. Alternatively, the camera may be an external device combined with a video processing unit for detecting the pointing position. The external device comprising the camera may be either connected to or integrated in the interactive lighting control system **10**, such as the camera **24** and the video processing unit **26** of the system **10**.

The input device **18** wirelessly transmits data **14** indicating the location **16**, to which it points in the real environment **30**, to the interface **12** of the interactive lighting control system **10**.

A light effect controller **20** of the interactive lighting control system **10** processes the received data **14** as follows: The real position of the location **16** is mapped to a virtual location of a virtual view of the real environment. The virtual view may be a 2D representation of the real environment such as the wall **30** shown in FIG. **1**. The virtual view may be for example created by capturing the real environment with the camera **24**. The virtual view may be also already stored in the interactive lighting control system **10**, for example by taking a picture of the wall **30** with a digital photo camera and transferring the taken picture to the system **10**.

The light effect controller **20** determines light effects available at the virtual location. This may be performed for example by means of a model of the lighting infrastructure **34** installed in the real environment, wherein the model relates the controls of the lighting infrastructure **34** to light effects and locations in the virtual view of the real environment.

The model may be created by a so called Dark Room Calibration (DRC) method, where the effect and location of every lighting control, for example a DMX channel, is measured. The light effects detected with a DRC can then be assigned to virtual locations in the virtual view to form the model. For example, a target illumination distribution can be expressed as a set of targets in discrete points, for example 500 lux on some points of a work surface, as a colorful distribution in a 2D view, for example the distribution measured on a wall, or the distribution as received by a camera or colorimetric device, or more abstractly, as a function that relates the light effect to a location.

The light effects, which are determined by the light effect controller **20** as being available at the location **16**, may be displayed on the display device **28** or transmitted via the interface **12** to the input device **18** or a separate light effects input device **40**, which may be for example implemented for example by a PDA (Personal Digital Assistant), a smart phone, a keyboard, a PC (Personal Computer), a remote control of for example a TV set.

A user selection of a desired light effect is transmitted from the input device **18** or the light effects input device **40** to the system **10**, and via the interface **12** to the light effects controller **20**, which transmits the selected light effect and the location **16** to the light effect creator **22**. The creator **22** traces back to the lamps **36** of the lighting infrastructure **34**, which influence the light in the location **16**, calculates the control settings for the traced back lamps **36**, and transmits the calculated control settings to the lighting infrastructure **34** so that the user desired light effect **32** is created by the lamps **36** at the location **16**.

In the following, the selection of light effects by the user **38** will be explained by means of several use cases. In the shown use cases, the cross marks the pointing position of the input device **18** and the dashed arrows represent movements performed with the input device **18**, i.e. the movement of the pointing location of the input device **18** from one to another location in the virtual view, which is a 2D representation of the real environment, for example the wall **30**.

The FIGS. **2-7** show some possible interactions between the input device **18** and the effects present in the virtual view. Because the content of the virtual view may be considered as a target light effect distribution, the lighting output may change accordingly, such that the user **38** may get an immediate feedback. This may result in an immersive fine tuning of the lighting atmosphere created by the lighting infrastructure **34**:

FIG. **2** shows a use case, where a light effect is selected from one location **161** and dragged to another location **162**. The desired light effect such as a spotlight is first at the location **161**. The user **38** may select the desired light effect by pointing with the input device **18** to the location **161**, pressing a certain button on the input device **18** and drag the so selected light effect to the new location **162**, where it should be created. At the new location **162**, marked with the cross, the user **38** releases the still pressed or presses the button again. The input device **18** may record the location **161** at the first button press and the location **162** at the release of the button press or the second button press and transmit both locations **161** and **162** as real location indicating data together with data related to the light effect, namely dragging the light effect on location **161** to location **162**, to the system **10**, which then creates the spotlight on location **161** on the new location **162**. This technical process for detecting a user interaction for selecting a desired light effect for a location and transmitting the data related to this selection is also performed with the further use cases described in the following.

FIG. **3** shows a use case, where a light effect such as a spotlight created with a redirect able lamp (or moving head) on a location **161** is selected and dragged to another location **162**. The interaction is the same as explained with regard to the use case shown in FIG. **2**. In this use case, it may be easier to place the light effect exactly at the user's desired new location **162**.

FIG. **4** shows a use case with functions in a virtual view to enhance the interaction. In some cases, more complex lighting targets (like gradients) need to be generated. In this case, a green effect **163** may be inserted in a red to blue gradient **164**. The location of the green effect affects the generation of the red→green and green→blue transition. The location of the green spot can be changed with the described drag interaction. In general, functions (like gradient generation) can be implemented in the view such that a richer interaction with the lighting system can be provided. These functions then react to the positioning of light effects in order to generate a more complex interaction.

FIG. **5** shows a further use case with location attractors **165**. Because the system **10** knows the location of the effects and effect maxima, it can use these locations **165** as "effect attractors". When dragging a light effect **166**, this will jump from attractor to attractor. This simplifies the positioning of an effect for the user, because effects are only placed on relevant places. This also enhances the immersive feedback to the user, because the location can be followed through the changes of the lighting itself. The definition of attractor is not limited to an effect maximum; also sensitive input places for functions can be relevant.

FIGS. **6** and **7** show further use cases integrating a display device with a color palette **167**. As described with regard to FIG. **1**, in the real environment, a display device **28** can be present, which may show a color palette **167** of light effects. The palette and arrangement on the screen may be controlled by the interactive lighting control system **10**. The location of the display device **28** can be integrated in the virtual view. Pointing to a color **168** of the palette **167** on the display device **28** can be detected in the virtual view, and in the view, there is no difference between the color blob on the display device and a light effect. This makes an interaction possible, similar to the use case shown in FIG. **2** and explained above: select an effect and drag it to another location. The color effect is dragged from the display device into the environment as if it was a light effect. Instead of a display device with a static color palette, it can also be a display device with some dynamic content, as shown in FIG. **7**. The dynamic content can contain multiple pixels **169**, and every pixel can change over time. Pixels in the dynamic content can also be mapped on to location attractors in the virtual view. Instead of a separate display device, the color palette and target color can also be displayed and selected on the input device **18** or the light effect input device **40**.

When pointing at a location, a display device can give some feedback on the possibilities at those locations. For example, a triangle of colors that can be rendered at the location can be shown on the input device or a separate display device.

When multiple effects are present, the interactive lighting control system **10** can select the most influencing effect at the location the user points to. It is also possible to influence a set of effects.

Finally, as in the known interaction with mouse and pointer, the user **38** can also indicate an area in the virtual view. This will select a set of effects that are mainly present in the area. Tuning operations are then performed on the set of effects.

Tuning operations possible on the selected area may be for example

change color temperature, hue, saturation and intensity;

smoothen or sharpen the effects: extremes in hue/saturation/intensity are weakened or strengthened.

To indicate the size of the selected area, the lamps that have a contribution to the area can start flashing or can be set by the interactive lighting control system **10** to a contrasting light effect. This provides the user **38** with a feedback on the selected area.

On the input device **18**, several interaction methods can be used for changing the light effect:

Buttons to change the hue, saturation and intensity of the (set of) effect(s) at which it is pointed.

These parameters can also be changed by moving the input device **18** upwards or downwards, and by using accelerometers to detect this movement.

Buttons or other input methods can be used to perform the "drag" operation. (Needed to move effects or to select an area).

A touch screen color circle or other arrangement which shows the hue, saturation and intensity of the pointed light effect, and which makes it possible to drive the hue, saturation and intensity to a value that satisfies the user.

When an area is selected, the shown values of hue, saturation and intensity can be average values, but also minima or maxima. In the latter case, the interaction makes it possible to change the extreme values. It is also possible to weaken or strengthen the distribution of extreme values in order to smoothen or sharpen the effect.

The invention can be used in environments where a large number of for example more than 20 luminaries is present, in future homes with a complex and diverse lighting infrastructure, in shops, public spaces, lobbies where light scenes are created, for chains of shops (one can think of a single reference shop, where light scenes are created for all shops; when the light scenes are deployed, some fine-tuning might be needed). The interaction is also useful for tuning the location of a redirect able spot. These spots are mainly used in shops (mannequins), art galleries, in theatres and on stages of concerts.

Typical applications of the invention are for example the creation of light scenes from scratch (areas are located and effects are increased from zero to a desired value), and the immersive fine-tuning of light scenes which are created by other generation methods.

At least some of the functionality of the invention may be performed by hard- or software. In case of an implementation in software, a single or multiple standard microprocessors or microcontrollers may be used to process a single or multiple algorithms implementing the invention.

It should be noted that the word "comprise" does not exclude other elements or steps, and that the word "a" or "an" does not exclude a plurality. Furthermore, any reference signs in the claims shall not be construed as limiting the scope of the invention.

The invention claimed is:

1. An interactive lighting control system, comprising:

an interface configured to receive data indicating a real location in a real environment from an input device, the real location derived by said input device based on processing of positional data obtained by pointing the input device at the real location, and wherein said interface is configured to receive data related to a light effect produced by one or more light sources desired at the real location;

a light effect controller configured to map the real location as determined by said input device to a virtual location of a virtual view of the real environment and determine light effects available by the one or more light sources at the virtual location by assigning light effects at the real location to the virtual location in the virtual view; and

a light effect creator configured to control said one or more light sources by providing feedback at the real location based on the received data indicating the real location and the received data related to the light effect produced by the one or more light sources desired at the real location, said feedback comprising an indication different from the light effect produced by the one or more light sources desired at the real location, and producing said desired light effect at the real location based on the light effects available at the virtual location.

2. The system of claim **1**, wherein said light effect creator is configured to calculate control settings for a lighting infrastructure to control said one or more light sources to produce the desired light effect on the real location based on the light effects available at the virtual location.

3. The system of claim **1**, wherein the input device comprises one or more of the following devices:

a first input device to derive the location from the detected position of infrared LEDs;

a second input device to derive the location from the detected position of coded beacons;

a light torch, which is detected by a camera;

a laser pointer, which is detected by a camera.

4. The system of claim **1**, further comprising a camera and a video processing unit configured to process video data received from the camera, to detect the location in the real environment at which the input device points, and to output the detected real location to the light effect controller for further processing.

5. The system of claim **1**, wherein the interface receives the data related to a light effect desired at the real location from a light effects input device.

6. The system of claim **1**, wherein the light effect controller indicates light effects available at the real location based on the virtual location in the virtual view and transmits available light effects to the input device, a display device, or an audio device for indication to a user.

7. The system of claim **6**, wherein the display device is controlled such that a static or dynamic content with light effects is displayed for selection with a light effects input device.

8. The system of claim **6**, wherein the data related to a light effect desired at the real location comprise one or more of the following:

data about the size of the real location at which the desired light effect should be created;

data about a light effect at a first real location dragged with an input device to a second real location at which the light effect should be created, too;

data about a light effect at a first real location dragged with an input device to a second real location to which the light effect should be moved;

data about a grading or fading effect in a particular area or spot.

9. The system of claim **6**, wherein the light effect creator traces back to lamps, which influence the light in the real location of the lighting infrastructure based on the virtual location and calculates the control settings for the lamps, which were traced back.

10. The input device for the system of claim **6**, comprising:

a pointing location detector configured to detect a location in the real environment, to which the input device points, and

a transmitter configured to transmit data indicating the detected location.

11. The input device of claim **10**, further comprising:

light effects input means configured to input a light effect desired at the location, to which the input device points, wherein data related to a desired inputted light effect are transmitted by the transmitter.

12. An interactive lighting control method, comprising the acts of:

receiving data indicating a real location in a real environment from an input device, the real location derived by processing of positional data obtained by pointing the input device at the real location, and wherein an interface is configured to receive data related to a light effect produced by one or more light sources desired at the real location;

mapping the real location as determined by said input device to a virtual location of a virtual view of the real environment and determining light effects available at the virtual location by assigning light effects at the real location to the virtual location in the virtual view; and

controlling light output of said one or more light sources to provide feedback at the real location based on the received data indicating the real location and the received data related to the light effect produced by one or more light sources desired at the real location, said feedback comprising an indication different from the light effect produced by the one or more light sources desired at the real location, and produce the desired light effect at the real location.

13. An interactive lighting control system, comprising:

an interface configured to:

receive, from an input device, data indicative of first and second real locations in a real environment, said input device configured to detect a location in the real environment by pointing to said location; and

receive data related to a light effect produced by one or more light sources desired at the first real location; and

a light effect controller configured to map the real location as detected by said input device to a virtual location of a virtual view of the real environment, and to determine light effects available at the virtual location, said light effect controller assigning light effects at the real location to the virtual location in the virtual view; and

a light effect creator configured to control said one or more light sources based on the received data indicating the first and second real locations and the received data related to the light effect and produce said desired light effect at the second real location based on the light effects available at the virtual location.

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